

DATA SHEET

TEA1064B

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

Product specification
File under Integrated Circuits, IC03A

March 1994

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

FEATURES

- Low DC line voltage; operates down to 1.8 V (excluding polarity guard)
- Voltage regulator with low voltage drop and adjustable static resistance
- DC line voltage adjustment facility
- Provides a supply for external circuits
- Dynamic limiting (speech-controlled) in transmit direction prevents distortion of line signal and sidetone
- Symmetrical high-impedance inputs (64 k Ω) for dynamic, magnetic or piezo-electric microphones
- Asymmetrical high-impedance input (32 k Ω) for electret microphones
- DTMF signal input
- Confidence tone in the earpiece during DTMF dialling
- Mute input for disabling speech during pulse or DTMF dialling
- Power-down input for improved performance during pulse dial or register recall (flash)
- Receiving amplifier for dynamic, magnetic or piezo-electric earpieces

- Large amplification setting ranges on microphone and earpiece amplifiers
- Line loss compensation (line current dependent) for microphone and earpiece amplifiers (not used for DTMF amplifier)
- Gain control curve adaptable to exchange supply
- Automatic disabling of the DTMF amplifier in extremely-low voltage conditions
- Microphone MUTE function available with switch
- MUTE, POWER-DOWN and DTMF input reference (pin V_{EE2}) can be connected either to V_{EE1} or SLPE.

GENERAL DESCRIPTION

The TEA1064B is a bipolar integrated circuit that performs all the speech and line interface functions required in fully electronic telephone sets. It performs electronic switching between dialling and speech. The IC operates at line voltages down to 1.8 V DC (with reduced performance) to facilitate the use of more telephone sets connected in parallel. The transmit signal on the line is dynamically limited (speech-controlled) to prevent distortion at high transmit levels of both the sending signal and the sidetone.

ORDERING INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
TEA1064B	20	DIL	plastic	SOT146 ⁽¹⁾
TEA1064BT	20	mini-pack	plastic	SO20; SOT163A ⁽²⁾

Notes

1. SOT146-1; 1998 Jun 18.
2. SOT163-1; 1998 Jun 18.

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{line}	line current operating range	note 1	11	–	140	mA
	normal operation with reduced performance		2	–	11	mA
I_{CC}	internal supply current	$V_{\text{CC}} = 2.8 \text{ V}$	–	1.3	1.6	mA
	power-down input LOW power-down input HIGH		–	60	82	μA
G_{v}	voltage gain range		44	–	52	dB
	microphone amplifier receiving amplifier		20	–	45	dB
G_{v}	line loss compensation ranges		5.7	6.1	6.5	dB
V_{exch}	gain control		36	–	60	V
R_{exch}	exchange supply voltage exchange feeding bridge resistance		400	–	1000	Ω
$V_{\text{LN(p-p)}}$	maximum output voltage swing on LN (peak-to-peak value)	$R_{16} = 392 \Omega$; $I_{\text{line}} = 15 \text{ mA}$				
		$I_{\text{p}} = 1.4 \text{ mA}$	3.55	3.80	4.05	V
		$I_{\text{p}} = 2.7 \text{ mA}$	3.25	3.50	3.75	V
V_{p}	supply for peripherals	$I_{\text{line}} = 15 \text{ mA}$				
		$I_{\text{p}} = 1.4 \text{ mA}$	2.5	2.7	–	V
		$I_{\text{p}} = 2.7 \text{ mA}$; $R_{\text{REG-SLPE}} = 20 \text{ k}\Omega$	2.9	3.1	–	V
V_{LN}	DC line voltage	$I_{\text{line}} = 15 \text{ mA}$				
		without $R_{\text{REG-SLPE}}$	3.25	3.5	3.75	V
		$R_{\text{REG-SLPE}} = 20 \text{ k}\Omega$	4.05	4.4	4.75	V
T_{amb}	operating ambient temperature range		–25	–	+75	$^{\circ}\text{C}$

Note

- For the TEA1064BT the maximum line current depends on the heat dissipating qualities of the mounted device.

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

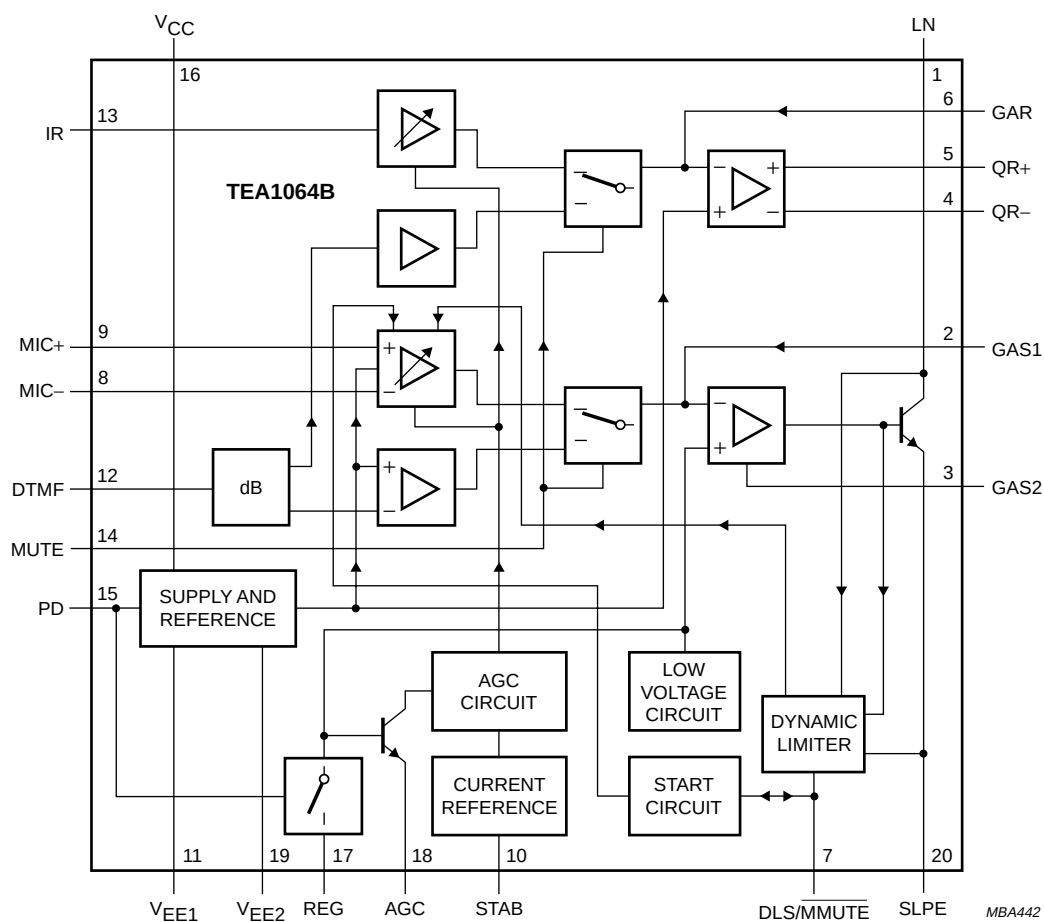


Fig.1 Block diagram.

Low voltage versatile telephone transmission circuit
with dialler interface and transmit level dynamic limiting

TEA1064B

PINNING

SYMBOL	PIN	DESCRIPTION
LN	1	positive line terminal
GAS1	2	gain adjustment; transmitting amplifier
GAS2	3	gain adjustment; transmitting amplifier
QR-	4	inverting output; receiving amplifier
QR+	5	non-inverting output; receiving amplifier
GAR	6	gain adjustment; receiving amplifier
DLS/MMUTE	7	decoupling for transmit amplifier dynamic and microphone MUTE input
MIC-	8	inverting microphone input
MIC+	9	non-inverting microphone input
STAB	10	current stabilizer
V _{EE1}	11	negative line terminal
DTMF	12	dual-tone multi-frequency input
IR	13	receiving amplifier input
MUTE	14	mute input
PD	15	power-down input
V _{CC}	16	internal supply decoupling
REG	17	voltage regulator decoupling
AGC	18	automatic gain control input
V _{EE2}	19	reference for POWER-DOWN (PD), MUTE and DTMF
SLPE	20	slope adjustment for DC curve/reference for peripheral circuits

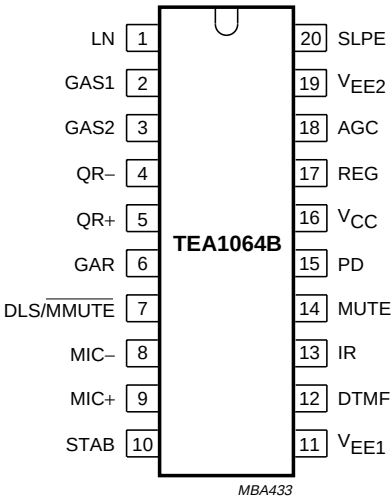


Fig.2 Pin configuration.

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

FUNCTIONAL DESCRIPTION

Supplies V_{CC} , V_{EE2} , LN, SLPE, REG and STAB (Figs 3 and 5)

Power for the TEA1064B and its peripheral circuits is usually obtained from the telephone line. The IC develops its own supply voltage at V_{CC} and regulates its voltage drop. The internal supply requires a decoupling capacitor between V_{CC} and V_{EE1} . The internal current stabilizer is set by a 3.6 k Ω resistor between STAB and V_{EE1} .

The DC current flowing into the set is determined by the exchange supply voltage V_{exch} , the feeding bridge resistance R_{exch} , the subscriber line DC resistance R_{line} and the DC voltage (including polarity guard) on the subscriber set (see Fig.3).

The internal voltage regulator generates a temperature-compensated reference voltage that is available between LN and SLPE ($V_{ref} = V_{LN-SLPE} = 3.23$ V typ.). This internal voltage regulator requires decoupling by a capacitor between REG and V_{EE1} (C3).

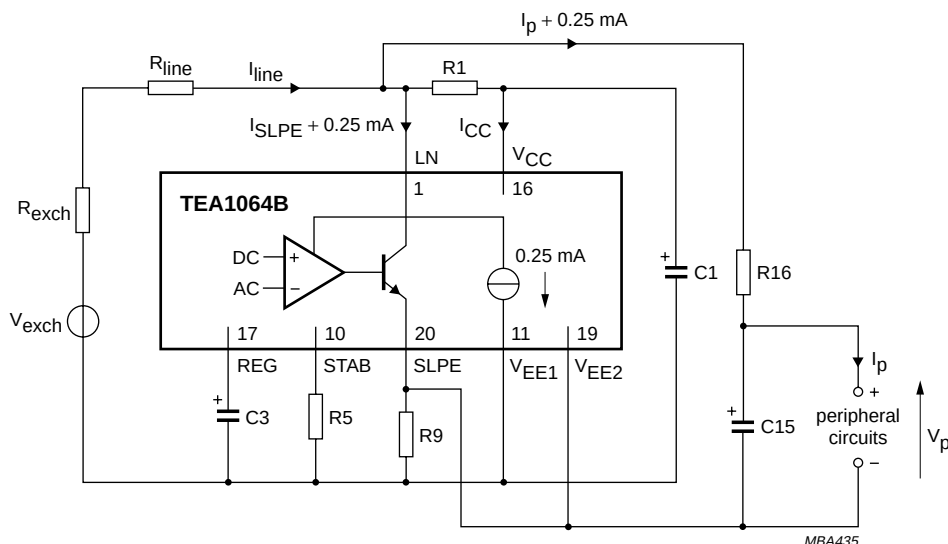
The configuration shown in Fig.3, gives a stabilized voltage across pins LN and SLPE which, applied via the low-pass filter R16, C15, provides a supply to the peripherals that is independent of the line current and depends only on the peripheral supply current.

The value of R16 and the level of the DC voltage $V_{LN-SLPE}$ determine the supply capabilities. In the basic application $R16 = 392 \Omega$ and $C15 = 220 \mu F$. The worst-case peripheral supply current as a function of supply voltage is shown in Fig.4.

To increase the supply capabilities, the value of R16 can be decreased or the DC voltage $V_{LN-SLPE}$ can be increased by using $R_{VA(REG-SLPE)}$.

Note

The TEA1064B application is the same as is used for TEA1060/TEA1061, TEA1067 and TEA1068 integrated circuits.



The voltage $V_{LN-SLPE}$ is fixed to $V_{ref} = 3.323 \pm 0.25$ V.

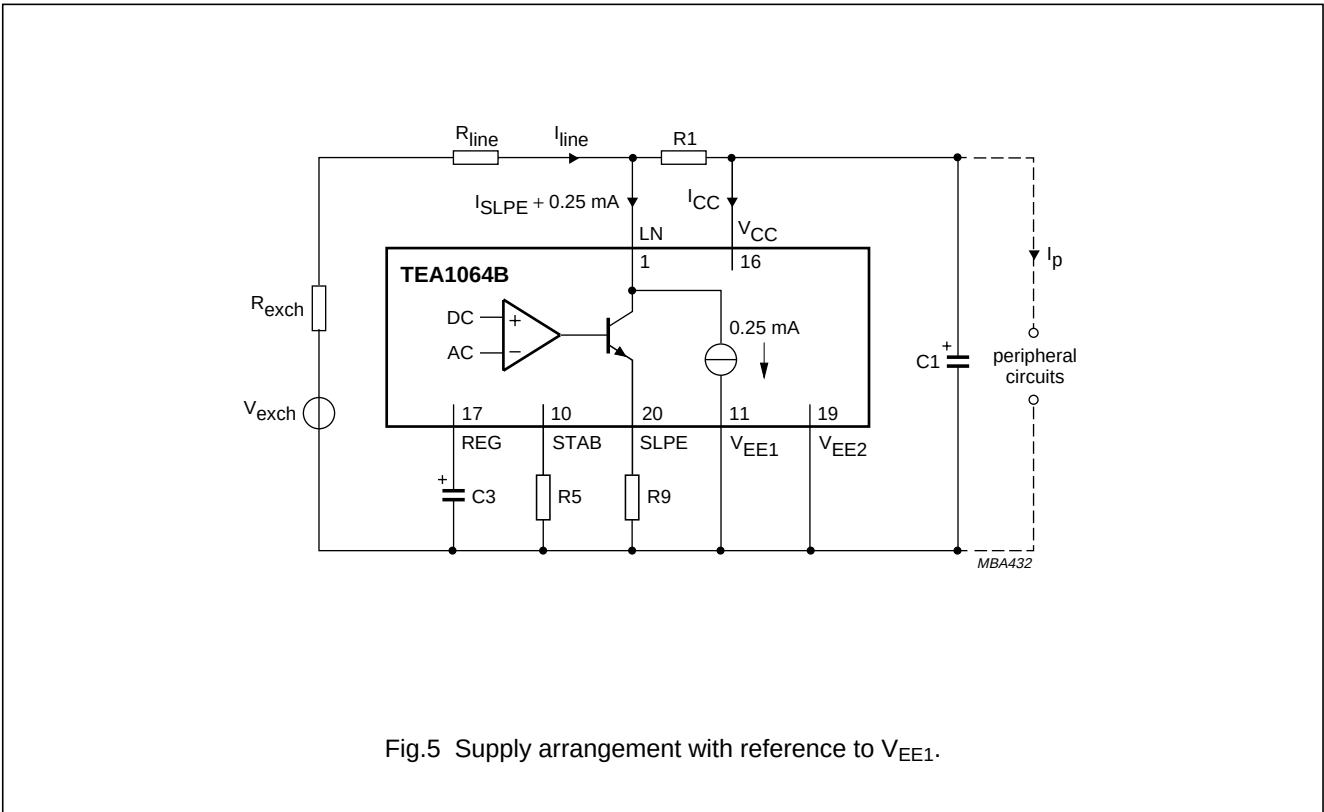
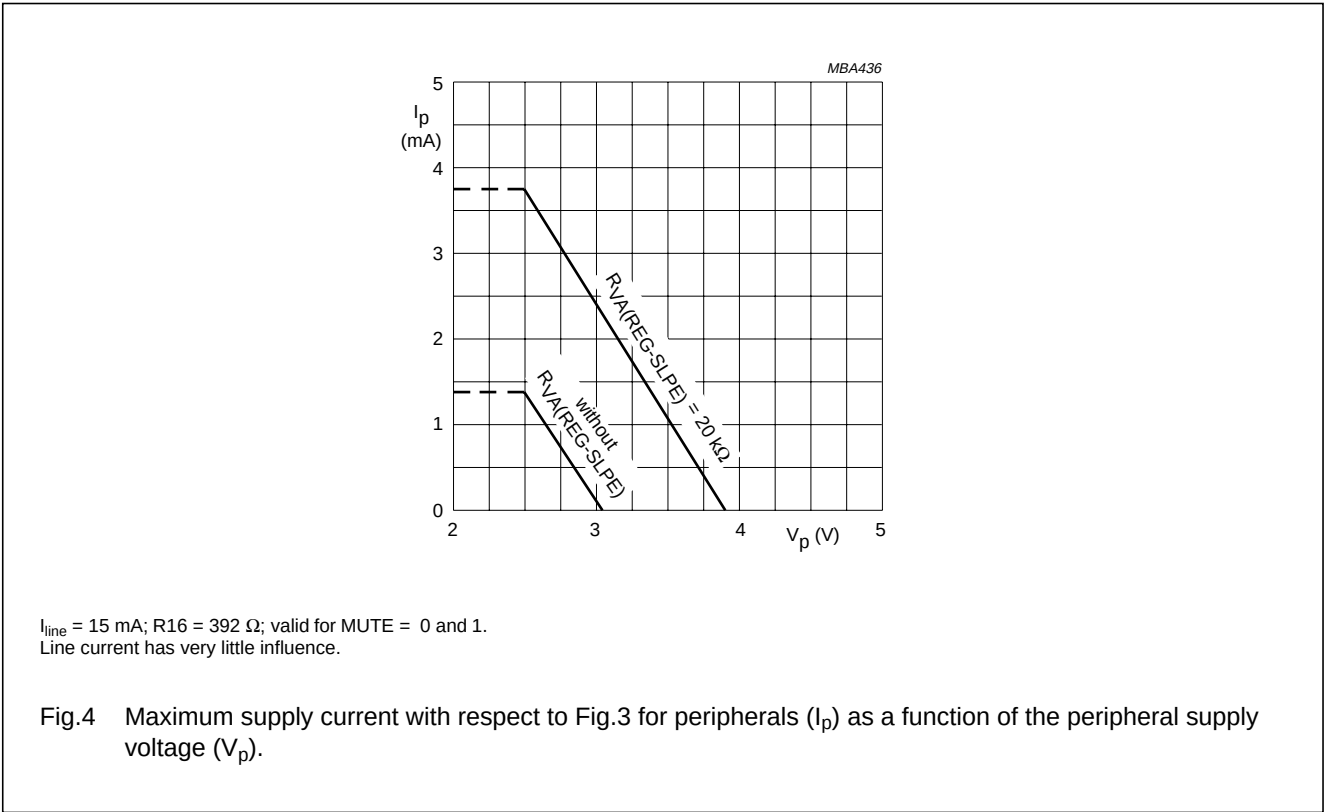
Resistor R16 together with the line current determine the supply capabilities and the maximum output swing on the line (no loop damping is necessary).

The line voltage $V_{LN} = V_{ref} + \{I_{line} - 1.55 \text{ mA}\} \times R9$.

Fig.3 Supply arrangement with reference to SLPE.

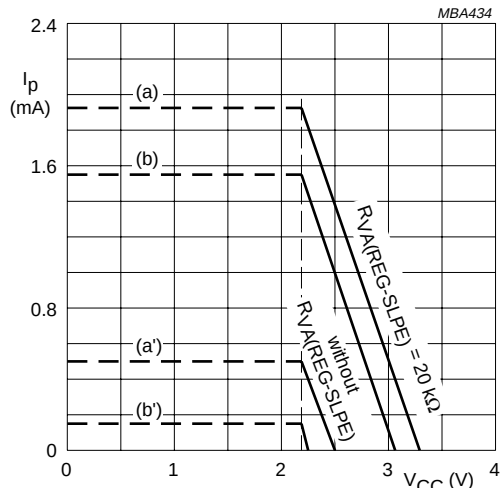
Low voltage versatile telephone transmission circuit
with dialler interface and transmit level dynamic limiting

TEA1064B



Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B



(a) $I_p = 1.94$ mA
 (b) $I_p = 1.54$ mA
 (a') $I_p = 0.54$ mA
 (b') $I_p = 0.16$ mA
 $I_{line} = 15$ mA
 $R1 = 620 \Omega$ and $R9 = 20 \Omega$
 Curve (a) and (a') are valid when the receiving amplifier is not driven or when MUTE = HIGH.
 Curve (b) and (b') are valid when the receiving amplifier is driven and when MUTE = LOW.
 $V_{o(RMS)} = 150$ mV, $R_T = 150 \Omega$.

Fig.6 Maximum current I_p with respect to Fig.5 available from V_{CC} for peripheral circuitry with $V_{CC} > 2.2$ V.

The maximum AC output swing on the line at low currents is influenced by $R16$ (limited by current) and the maximum output swing on the line at high currents is influenced by DC voltage $V_{LN-SLPE}$ (limited by voltage). In both these situations, the internal dynamic limiter in the sending channel prevents distortion when the microphone is overdriven. The maximum AC output swing on LN is shown in Fig.7; practical values for $R16$ are from 200Ω to 600Ω and this influences both maximum output swing at low line currents and the supply capabilities.

When the SLPE pin is the reference for peripheral circuits, inputs MUTE, PD and DTMF must be referenced to SLPE. This is achieved by connecting pin V_{EE2} to pin SLPE; V_{EE2} being the reference of MUTE, PD and DTMF input stages.

Active microphones can be supplied between V_{CC} and V_{EE1} as shown in Fig.5. Low power circuits that provide MUTE, PD and DTMF inputs to the TEA1064B can also be powered from V_{CC} (see Fig.6 for the supply capability of

V_{CC}). MUTE, PD and DTMF are then referenced to V_{EE1} and the pin V_{EE2} must therefore be connected to V_{EE1} .

If the line current I_{line} exceeds $I_{CC} + 0.25$ mA, the voltage converter shunts the excess current to SLPE via LN; where $I_{CC} \approx 1.3$ mA, the value required by the IC for normal operation.

The DC line voltage on LN is:

- $V_{LN} = V_{LN-SLPE} + (I_{SLPE} \times R9)$
- $V_{LN} = V_{ref} + \{(I_{line} - I_{CC} - 0.25 \times 10^{-3} \text{ A}) \times R9\}$

in which:

- $V_{ref} = 3.23 \text{ V} \pm 0.25 \text{ V}$ is the internal reference voltage between LN and SLPE; its value can be adjusted by external resistor R_{VA} .
- $R9$ = external resistor between SLPE and V_{EE1} (20Ω in basic operation).

With $R9 = 20 \Omega$, this results in:

- $V_{LN} = 3.3 \pm 0.25 \text{ V}$ at $I_{line} = 15 \text{ mA}$
- $V_{LN} = 4.1 \pm 0.3 \text{ V}$ at $I_{line} = 15 \text{ mA}$, $R_{VA(REG-SLPE)} = 33 \text{ k}\Omega$
- $V_{LN} = 4.4 \pm 0.35 \text{ V}$ at $I_{line} = 15 \text{ mA}$,
 $R_{VA(REG-SLPE)} = 20 \text{ k}\Omega$

The preferred value for $R9$ is 20Ω . Changing $R9$ influences microphone gain, DTMF gain, the gain control characteristics, sidetone and the DC characteristics (especially the low voltage characteristics).

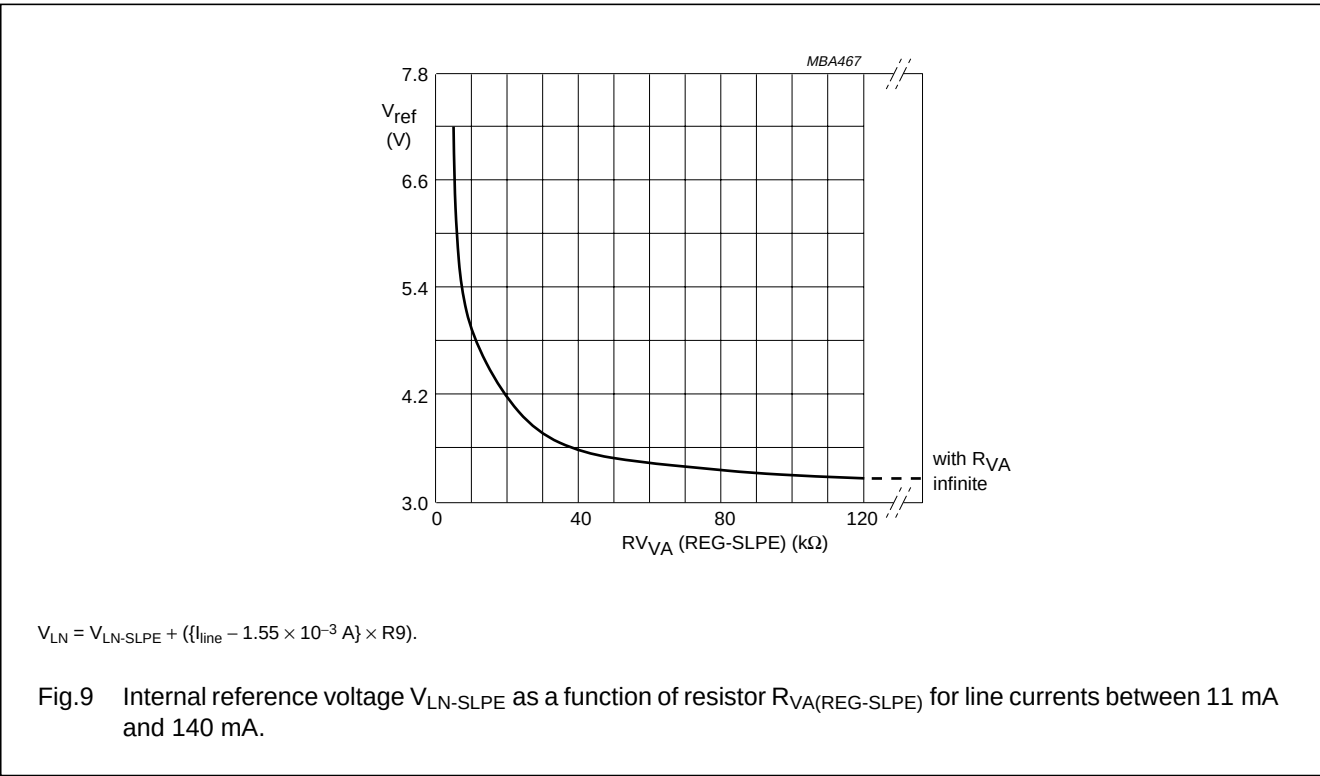
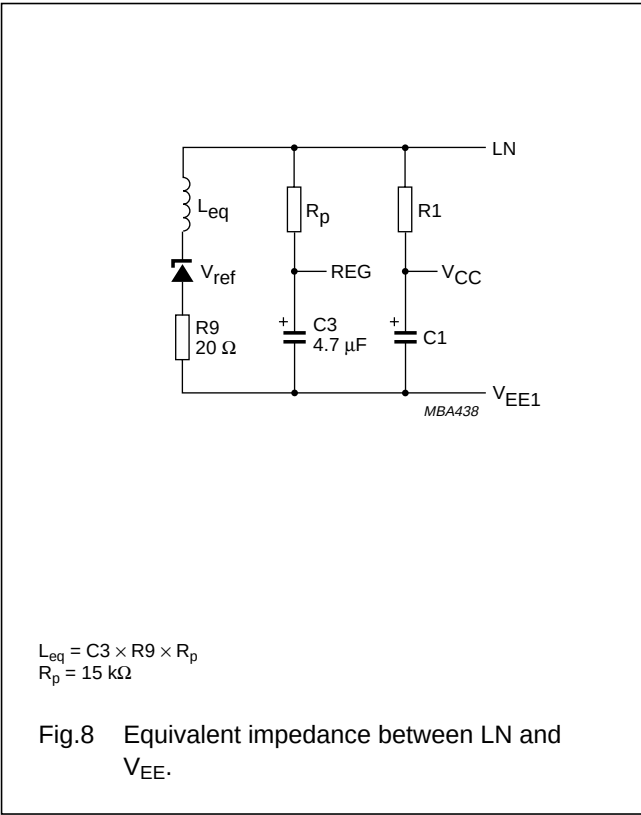
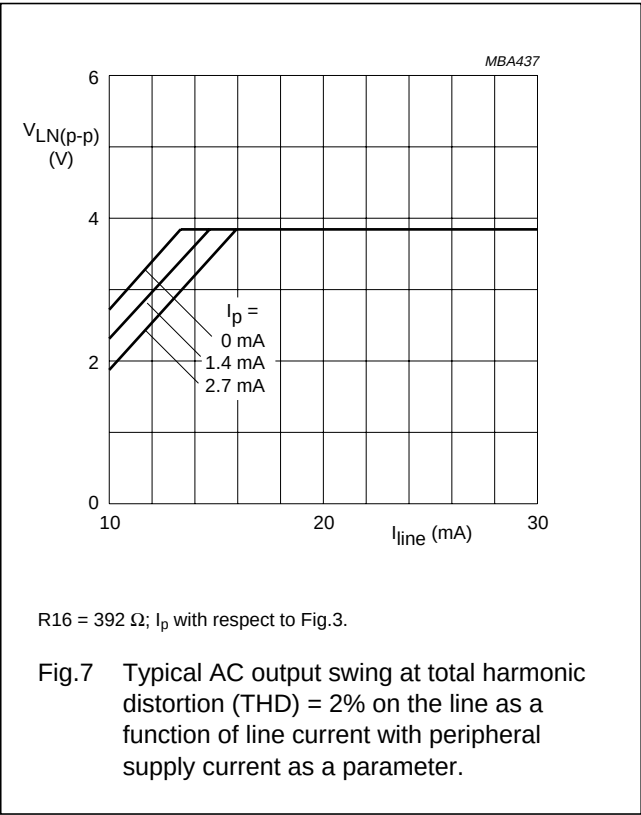
In normal conditions, $I_{SLPE} \gg (I_{CC} + 0.25 \text{ mA})$ and the static behaviour is equivalent to a voltage regulator diode with an internal resistance of $R9$. In the audio frequency range the dynamic impedance is determined mainly by $R1$. The equivalent impedance of the circuit in audio frequency range is shown in Fig.8.

The internal reference voltage $V_{LN-SLPE}$ can be increased by external resistor $R_{VA(REG-SLPE)}$ connected between REG and SLPE. The voltage $V_{LN-SLPE}$ is shown as a function of $R_{VA(REG-SLPE)}$ in Fig.9. Changing the reference voltage influences the output swing of both sending and receiving amplifiers.

At line currents below 8 mA (typ.), the DC voltage dropped across the circuit is adjusted to a lower level automatically (approximately 1.8 V at 2 mA). This gives the possibility of operating more telephone sets in parallel with DC line voltages (excluding polarity guard) down to an absolute minimum of 1.8 V . At line currents below 8 mA (typ.), the circuit has limited sending and receiving levels.

Low voltage versatile telephone transmission circuit
with dialler interface and transmit level dynamic limiting

TEA1064B



Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

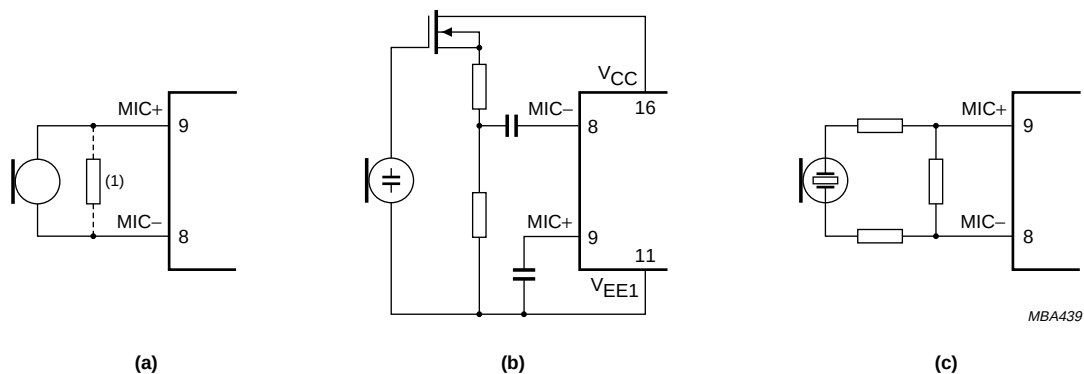
TEA1064B

Microphone inputs MIC+ and MIC– and gain pins GAS1 and GAS2

The TEA1064B has symmetrical microphone inputs, its input impedance is 64 k Ω (2 x 32 k Ω) and its voltage amplification is typically 52 dB with R7 = 68 k Ω . Either dynamic, magnetic or piezo-electric microphones can be used, or an electret microphone with a built-in FET buffer. Arrangements for the microphone types are shown in Fig.10.

The gain of the microphone amplifier is proportional to external resistor R7 connected between GAS1 and GAS2 and with this it can be adjusted between 44 dB and 52 dB to suit the sensitivity of the transducer.

An external 100 pF capacitor (C6) is required between GAS1 and SLPE to ensure stability. A larger value of C6 may be chosen to obtain a first-order low-pass filter with a cut-off frequency corresponding to the time constant R7 x C6.



Resistor (1) may be connected to reduce the terminating impedance, or for sensitive types a resistive attenuator can be used to prevent overloading the microphone inputs.

Fig.10 Microphone arrangements (a) magnetic or dynamic microphone (b) electret microphone (c) piezo-electric microphone currents.

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

Dynamic limiter (microphone) pin DLS/MMUTE

A low level at the DLS/MMUTE pin inhibits the microphone inputs MIC+ and MIC– but has no influence on the receiving and DTMF amplifiers.

Removing the low level at the DLS/MMUTE pin provides the normal function of the microphone amplifier after a short time determined by the capacitor connected to DLS/MMUTE pin. The microphone mute function can be realised by a simple switch as shown in Fig.11.

To prevent distortion of the transmitted signal, the gain of the sending amplifier is reduced rapidly when peaks of the signal on the line exceed an internally-determined threshold. The time in which gain reduction is effected (attack time) is very short. The circuit stays in the gain-reduced condition until the peaks of the sending signal remain below the threshold level. The sending gain then returns to normal after a time determined by the capacitor connected to DLS/MMUTE (release time).

The internal threshold adapts automatically to the DC voltage setting of the circuit ($V_{LN-SLPE}$). This means that the maximum output swing on the line will be higher if the DC voltage dropped across the circuit is increased.

Fig.12 shows the maximum possible output swing on the line as a function of the DC voltage drop ($V_{LN-SLPE}$) with $I_{line} - I_p$ as a parameter.

The internal threshold level is lowered automatically if the DC current in the transmit output stage is insufficient. This prevents distortion of the sending signal in applications using parallel-connected telephones or telephones operating over long lines, for example.

Dynamic limiting also considerably improves sidetone performance in over-drive conditions (less distortion; limited sidetone level).

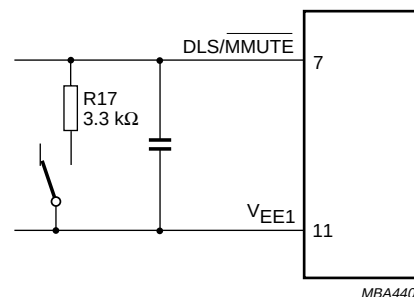
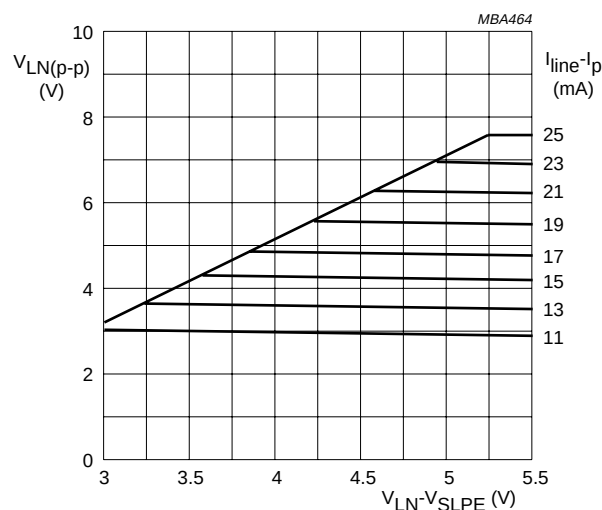


Fig.11 Microphone-mute function.



R16 = 392 Ω.

Fig.12 Typical output swing on line as a function of the DC voltage drop $V_{LN-SLPE}$ with $I_{line} - I_p$ as a parameter.

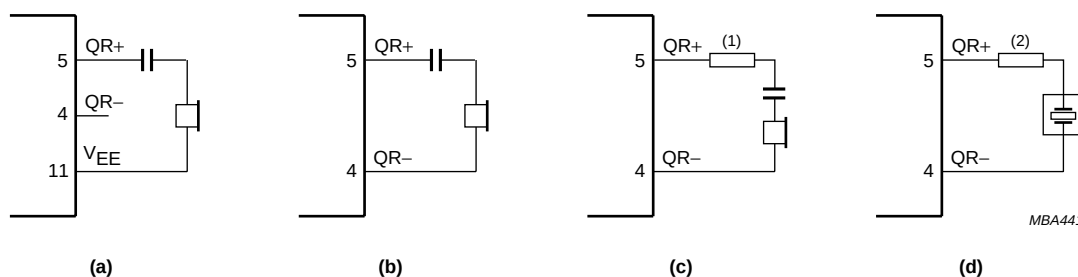
Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

Receiving amplifier IR, QR+, QR– and GAR

The receiving amplifier has one input IR and two complimentary outputs, QR+ (non-inverting) and QR– (inverting). These outputs may be used for single-ended or differential drive, depending on the type and sensitivity of the earpiece used (see Fig.13). Gain from IR to QR+ is typically 31 dB with $R_4 = 100\text{ k}\Omega$, sufficient for

low-impedance magnetic or dynamic earpieces which are suitable for single-ended drive. By using both outputs (differential drive) the gain is increased by 6 dB. Differential drive can be used when the earpiece impedance exceeds $450\ \Omega$ as with high-impedance dynamic, magnetic or piezo-electric earpieces.



Resistor (1) may be connected to prevent distortion (inductive load).
Resistor (2) is required to increase the phase margin (stability with capacitive load).

Fig.13 Alternative receiver arrangements (a) dynamic earpiece with an impedance less than $450\ \Omega$
(b) dynamic earpiece with an impedance more than $450\ \Omega$
(c) magnetic earpiece with an impedance more than $450\ \Omega$
(d) piezo-electric earpiece.

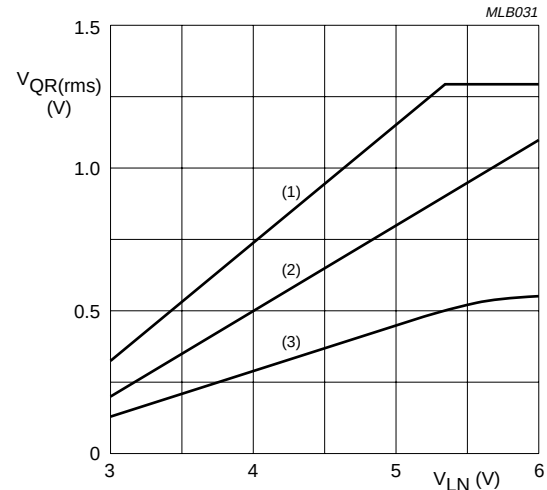
Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

The output voltage of the receiving amplifier is specified for continuous-wave drive. Fig.14 shows the maximum output swing of the receiving amplifier as a function of the DC voltage drop (V_{LN}). The maximum output voltage will be higher under speech conditions, where the ratio of the peak to the RMS value is higher.

The gain of the receiving amplifier can be adjusted to suit the sensitivity of the transducer used. The adjustment range is between 20 dB and 39 dB with single-ended drive and between 26 dB and 45 dB with differential drive. The gain is proportional to the external resistor R4 connected between GAR and QR+. The overall gain between LN and QR+ can be found by subtracting the attenuation of the anti-sidetone network (32 dB) from the amplifier gain.

Two external capacitors ($C4 = 100$ pF and $C7 = 10 \times C4 = 1$ nF) ensure stability. A larger value may be chosen to obtain a first-order low-pass filter. The cut-off frequency corresponds with time constant $R4 \times C4$. The relationship $C7 = 10 \times C4$ must be maintained.



Valid for both options; THD = 2%, $I_{line} = 15$ mA.
 Curve (1) is for a differential load of 47 nF (series resistance = 100 Ω ; $f = 3400$ Hz).
 Curve (2) is for a differential load of 450 Ω ; $f = 1$ kHz.
 Curve (3) is for a single-ended load of 150 Ω ; $f = 1$ kHz.

Fig.14 Typical output swing of the receiving amplifier as a function of DC voltage drop V_{LN} with the load at the receiver output as parameter.

Low voltage versatile telephone transmission circuit
with dialler interface and transmit level dynamic limiting

TEA1064B

Automatic gain control input AGC

Automatic compensation of line loss is obtained by connecting a resistor (R6) between AGC and V_{EE1}.

This automatic gain control varies the gain of the microphone amplifier and receiving amplifier in accordance with the DC line current. The control range is 6.1 dB; this corresponds to a 5 km line of 0.5 dB diameter copper twisted-pair cable (DC resistance = 176 Ω/km, average attenuation = 1.2 dB/km). The DTMF gain is not affected by this feature.

The value of R6 must be chosen with reference to the exchange supply voltage and its feeding bridge resistance (see Fig.15 and Table 1). Different values of R6 give the same line current ratios at the start and the end of the control range. If automatic line-loss compensation is not required the AGC pin can be left open-circuit, the amplifiers then provide their maximum gain.

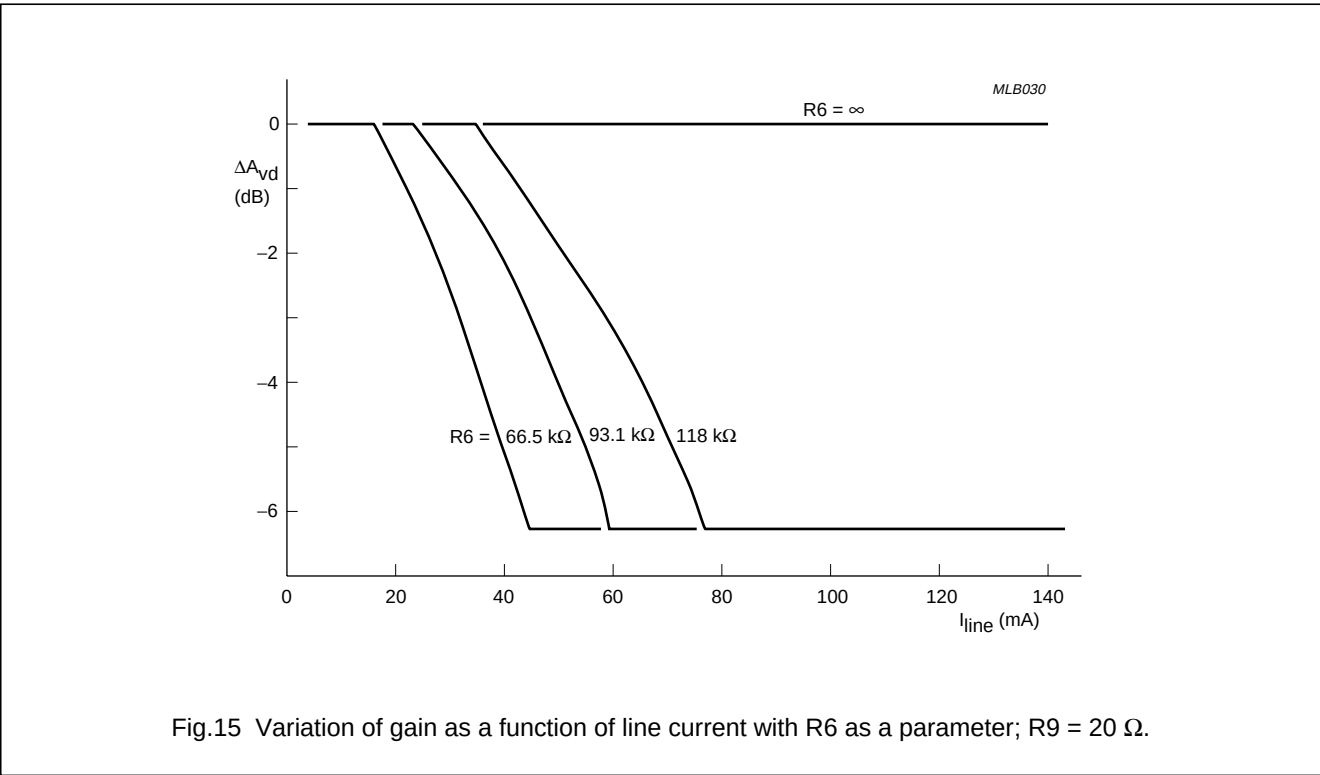


Fig.15 Variation of gain as a function of line current with R6 as a parameter; R9 = 20 Ω.

Table 1 Values of R6 giving optimum line-loss compensation at various values of exchange supply voltage (V_{exch}) and exchange feeding bridge resistance (R_{exch}); R9 = 20 Ω

		R _{exch} (Ω)			
		400	600	800	1000
		R6 (kΩ)			
V _{exch} (V)	35	84.5	66.5	x	x
	48	118	93.1	77.8	66.5
	60	x	x	97.6	84.5

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

V_{EE2} input

V_{EE2} is the reference for MUTE, POWER-DOWN and DTMF inputs. These signals are referenced to V_{EE1} when generated by peripherals powered between V_{CC} and V_{EE1} , but they can also be referenced to SLPE when peripherals are powered as shown in Fig.3. In the first instance (reference to V_{EE1}), V_{EE2} has to be connected to V_{EE1} . In the second instance (reference to SLPE), V_{EE2} has to be connected to SLPE.

MUTE input (see notes 1 and 2)

MUTE = HIGH enables the DTMF input and inhibits the microphone and receiving amplifier inputs.

MUTE = LOW or open-circuit disables the DTMF input and enables the microphone and receiving amplifier inputs.

Switching MUTE gives negligible clicks at the telephone outputs and on the line.

Dual-tone multi-frequency input DTMF (see note 1)

When the DTMF input is enabled, dialling tones may be sent on the line. The voltage gain between DTMF- V_{EE2} and LN- V_{EE1} is typically 26.5 dB less than the gain of the microphone amplifier and varies with R7 in the same way as the gain of the microphone amplifier. This means that the tone level at the DTMF input has to be adjusted after setting the gain of the microphone amplifier.

With R7 = 68 k Ω the gain is typically 25.5 dB.

The signalling tones can be heard in the earpiece at a low level (confidence tone).

Power-down input PD (see notes 1. and 2.)

During pulse dialling or register recall (timed loop break) the telephone line is interrupted; as a consequence it provides no supply for the transmission circuit connected to V_{CC} or for the peripherals between V_{LN} and SLPE.

These supply gaps are bridged by the charges in the capacitors C1 and C15. The requirements on these capacitors are eased by an applied HIGH level to the PD input during the time of the loop break. This reduces the internal supply current I_{CC1} from 1.3 mA (typ.) to 60 μ A (typ.) and switches off the voltage regulator to prevent discharge via LN to V_{CC2} .

A HIGH level at PD also internally disconnects the capacitor at REG so that the voltage stabilizer has no switch-on delay after line interruptions. This minimizes the contribution of the IC to the current waveform during pulse dialling or register recall.

When the power-down facility is not required, the PD pin can be left open-circuit or connected to V_{EE2} .

Sidetone suppression

Suppression of the transmitted signal in the earpiece is obtained by the anti-sidetone network comprising R1// Z_{line} , R2, R3, R8, R9 and Z_{bal} (see Fig.16). Maximum compensation is obtained when the following conditions are fulfilled:

$$(a) \quad R9 \times R2 = R1 \times (R3 + \{R8/Z_{bal}\})$$

$$(b) \quad (Z_{bal}/\{Z_{bal} + R8\}) = (Z_{line}/\{Z_{line} + R1\})$$

If fixed values are chosen for R1, R2, R3 and R9, then condition (a) is always fulfilled provided $|R8/Z_{bal}| << R3$

To obtain optimum sidetone suppression, condition (b) has to be fulfilled, resulting in:

$$Z_{bal} = (R8/R1) \times Z_{line} = k \times Z_{line}$$

Where k is a scale factor; $k = (R8/R1)$.

The scale factor k (value of R8) is chosen to meet the following criteria:

- compatibility with a standard capacitor from the E6 or E12 range for Z_{bal}
- $|Z_{bal}/R8| << R3$ to fulfil condition (a) and thus ensure correct anti-sidetone bridge operation
- $|Z_{bal} + R8| >> R9$ to avoid influencing the transmit gain

In practise Z_{line} varies considerably with the line length and line type. Therefore the value chosen for Z_{bal} should be for an average line length giving satisfactory sidetone suppression with short and long lines. The suppression also depends on the accuracy of the match between Z_{bal} and the impedance of the average line.

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

EXAMPLE

The line impedance for which optimum suppression is to be obtained can be represented by $210\ \Omega + (1265\ \Omega // 140\ \text{nF})$. This represents a 5 km line of 0.5 mm diameter copper twisted-pair cable matched with $600\ \Omega$ ($176\ \Omega/\text{km}$; $38\ \text{nF/km}$).

With $k = 0.64$ this results in : $R_8 = 390\ \Omega$;
 $Z_{\text{bal}} = 130\ \Omega + (820\ \Omega // 220\ \text{nF})$.

The anti-sidetone network for the TEA1060 family shown in Fig.16 attenuates the signal received from the line by 32 dB before it enters the receiving amplifier. The attenuation is almost constant over the whole audio-frequency range.

Alternatively a conventional Wheatstone bridge can be used as an anti-sidetone circuit (see Fig.17). Both bridge types can be used with either resistive or complex set impedances. (More information on the balancing of anti-sidetone bridges can be obtained in our publication "Versatile speech transmission ICs for electronic telephone sets", order number 9398 341 10011).

Notes

1. The reference level used for the MUTE, DTMF and PD inputs is V_{EE2} .
2. A LOW level for any of these pins is defined by connection to V_{EE2} , a HIGH level is defined as a voltage greater than $V_{EE2} + 1.5\ \text{V}$ and smaller than $V_{CC} + 0.4\ \text{V}$.

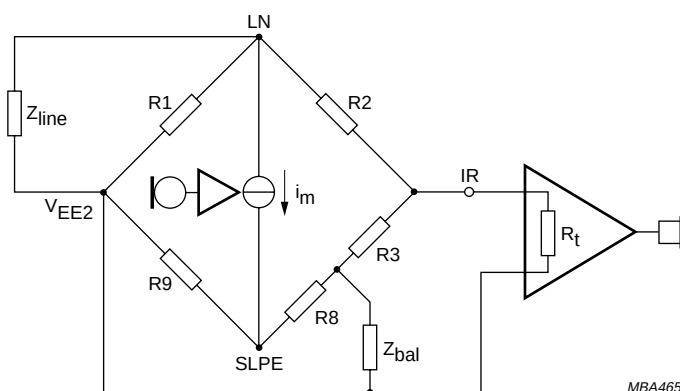


Fig.16 Equivalent circuit of TEA1060 family anti-sidetone bridge.

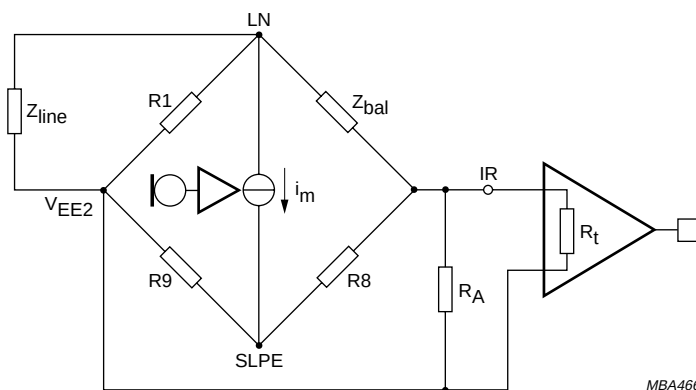


Fig.17 Equivalent circuit of an anti-sidetone network in the Wheatstone bridge configuration.

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{LN}	positive line voltage continuous		–	12	V
V_{LN}	repetitive line voltage during switch-on line interruption		–	13.2	V
V_{LN}	repetitive peak line voltage one 1 ms pulse per 5 s	R9 = 20 Ω ; R10 = 13 Ω ; see Fig.22	–	28	V
I_{LN}	line current	R9 = 20 Ω			
	TEA1064B	note 1	–	140	mA
	TEA1064BT	note 1	–	140	mA
V_i	input voltage on pins other than LN		$V_{EE1}-0.7$	$V_{CC}+0.7$	V
P_{tot}	total power dissipation	R9 = 20 Ω ; note 2			
	TEA1064B		–	717	mW
	TEA1064BT		–	555	mW
T_{amb}	operating ambient temperature		–25	+75	°C
T_{stg}	storage temperature		–40	+125	°C
T_j	junction temperature		–	+125	°C

Notes

- Mostly dependent on the maximum required T_{amb} and on the voltage between LN and SLPE. See Figs 18 and 19 to determine the current as a function of the required voltage and the temperature.
- Calculated for the maximum ambient temperature specified $T_{amb} = 75$ °C and a maximum junction temperature of 125 °C.

THERMAL RESISTANCE

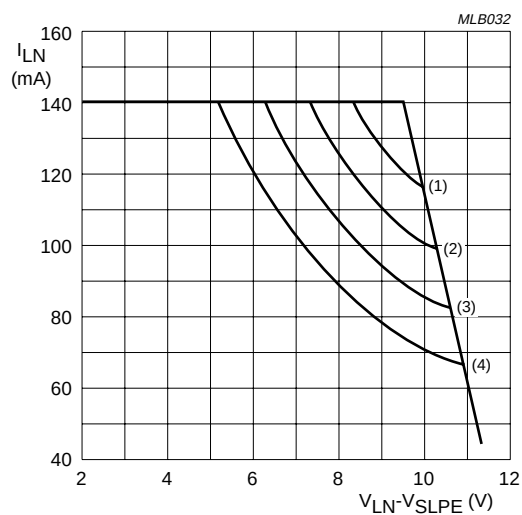
SYMBOL	PARAMETER	THERMAL RESISTANCE
$R_{th\ j-a}$	from junction to ambient in free air	
	SOT146	70 K/W
	SOT163A (note 1)	90 K/W

Note

- Mounted on glass epoxy board 41 × 19 × 1.5 mm.

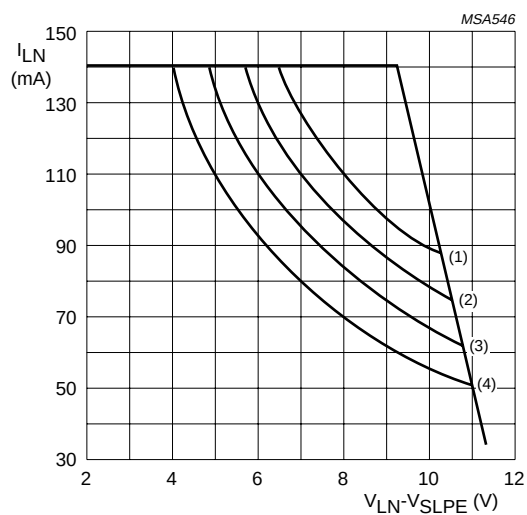
Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B



- (1) $T_{amb} = 45\text{ }^{\circ}\text{C}$; $P_{tot} = 1143\text{ mW}$.
 (2) $T_{amb} = 55\text{ }^{\circ}\text{C}$; $P_{tot} = 1000\text{ mW}$.
 (3) $T_{amb} = 65\text{ }^{\circ}\text{C}$; $P_{tot} = 857\text{ mW}$.
 (4) $T_{amb} = 75\text{ }^{\circ}\text{C}$; $P_{tot} = 714\text{ mW}$.

Fig.18 TEA1064B safe operating area.



- (1) $T_{amb} = 45\text{ }^{\circ}\text{C}$; $P_{tot} = 888\text{ mW}$.
 (2) $T_{amb} = 55\text{ }^{\circ}\text{C}$; $P_{tot} = 777\text{ mW}$.
 (3) $T_{amb} = 65\text{ }^{\circ}\text{C}$; $P_{tot} = 666\text{ mW}$.
 (4) $T_{amb} = 75\text{ }^{\circ}\text{C}$; $P_{tot} = 555\text{ mW}$.

Fig.19 TEA1064BT safe operating area.

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

CHARACTERISTICS

$I_{line} = 11$ to 140 mA; $V_{EE1} = 0$ V; $f = 800$ Hz; $T_{amb} = 25$ °C; $R_L = 600$ Ω ; tested in the circuits of Fig.20 or Fig.21; V_{EE2} connected to SLPE; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies LN and V _{CC} (pins 1 and 16)						
V _{LN}	DC line voltage: voltage drop between LN and V _{EE1}	MIC–, MIC+ inputs open-circuit; without R _{VA} I _{line} = 2 mA I _{line} = 4 mA I _{line} = 7 mA I _{line} = 11 mA I _{line} = 15 mA I _{line} = 100 mA I _{line} = 140 mA	– – – – 3.25 – –	1.8 2.2 3.2 3.4 3.5 5.25 6.1	– – – – 3.75 6.05 7.0	V V V V V V V
ΔV _{LN} /ΔT	variation with temperature	I _{line} = 15 mA	–3	–1	+1	mV/K
V _{LN}	voltage drop over circuit with R _{VA} connected between REG and SLPE	R _{VA} = 33 kΩ R _{VA} = 20 kΩ	3.8 4.05	4.1 4.4	4.4 4.75	V V
I _{CC}	internal supply current into pin 16	V _{CC} = 2.8 V PD = LOW PD = HIGH	– –	1.3 60	1.6 82	mA μA
V _{CC}	supply voltage available for peripheral circuitry V _{EE2} connected to V _{EE1}	I _{line} = 15 mA; MUTE = HIGH; see Fig.5 I _p = 0.54 mA I _p = 0 mA	 2.2 2.5	 2.4 2.7	 – –	 V V
V _p	supply voltage available for peripheral circuitry	I _{line} = 15 mA I _p = 1.4 mA I _p = 2.7 mA; R _{REG-SLPE} = 20 kΩ	 2.5 2.9	 2.7 3.1	 – –	 V V
Microphone inputs MIC– and MIC+ (pins 8 and 9)						
Z _i	input impedance differential single-ended		51 25.5	64 32.0	77 38.5	kΩ kΩ
CMRR	common mode rejection ratio		–	82	–	dB
G _v	voltage gain (see Fig.20)	I _{line} = 15 mA; R7 = 68 kΩ	51	52	53	dB
ΔG _v f	variation of G _v with frequency referred to 0.8 kHz	f = 300 and 3400 Hz	–0.5	±0.1	+0.5	dB

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$\Delta G_V T$	variation of G_V with temperature referred to 25 °C	without R6; $I_{line} = 50 \text{ mA}$; $T_{amb} = -25 \text{ to } +75 \text{ °C}$	–	± 0.2	–	dB
DTMF input (pin 12)						
Z_i	input impedance		16.8	20.7	24.6	k Ω
G_V	voltage gain (see Fig.20)	$I_{line} = 15 \text{ mA}$; $R7 = 68 \text{ k}\Omega$	24.5	25.5	26.5	dB
$\Delta G_V f$	variation of G_V with frequency referred to 0.8 kHz	$f = 300 \text{ and } 3400 \text{ Hz}$	–0.5	± 0.01	+0.5	dB
		$f = 697 \text{ and } 1633 \text{ Hz}$	–0.2	± 0.05	+0.2	dB
$\Delta G_V T$	variation of G_V with temperature referred to 25 °C	$I_{line} = 50 \text{ mA}$; $T_{amb} = -25 \text{ to } +75 \text{ °C}$	–	± 0.2	0.5	dB
Gain adjustment inputs GAS1 and GAS2 (pins 2 and 3)						
ΔG_V	transmitting amplifier gain adjustment range		–8	–	+0	dB
Sending amplifier output LN (pin 1)						
DYNAMIC LIMITER						
$V_{LN(p-p)}$	output voltage swing (peak-to-peak value)	$I_{line} = 15 \text{ mA}$; $R7 = 68 \text{ k}\Omega$; $V_{i(RMS)} = 3.6 \text{ mV}$	3.4	3.8	4.2	V
THD	total harmonic distortion	$V_i = 3.6 \text{ mV } +10 \text{ dB}$	–	1.5	–	%
		$V_i = 3.6 \text{ mV } +15 \text{ dB}$	–	2.8	–	%
$V_{LN(p-p)}$	output voltage swing (peak-to-peak value)	$V_i = 3.6 \text{ mV } +10 \text{ dB}$				
		$I_p = 1.4 \text{ mA}$	3.55	3.8	4.05	V
		$I_p = 2.7 \text{ mA}$	3.25	3.5	3.75	V
		$I_p = 0 \text{ mA}; I_{line} = 7 \text{ mA}$	–	1.8	–	V
t_{att}	dynamic behaviour of limiter attack time V_{mic} jumps from 2 mV to 40 mV	$C16 = 470 \text{ nF}$	–	1.5	5.0	ms
			50	150	–	ms
$V_{no(RMS)}$	noise output voltage (RMS value)	$I_{line} = 15 \text{ mA}$; $R7 = 68 \text{ k}\Omega$; 200 Ω between MIC– and MIC+; psophometrically weighted (P53 curve)	–	–72	–	dBmp

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Receiving amplifier input IR (pin 13)						
Z_i	input impedance		17	21	25	k Ω
Receiving amplifier outputs QR– and QR+ (pins 4 and 5)						
Z_o	output impedance	single-ended	–	4	–	Ω
G_v	voltage gain (see Fig.21)	$I_{line} = 15 \text{ mA};$ $R_4 = 100 \text{ k}\Omega$				
	single-ended	$R_T = 300 \Omega$	30	31	32	dB
	differential	$R_T = 600 \Omega$	36	37	38	dB
$\Delta G_v f$	variation of G_v with frequency referred to 0.8 kHz	$f = 300 \text{ and } 3400 \text{ Hz}$	–0.5	–0.2	0	dB
$\Delta G_v T$	variation of G_v with temperature referred to 25 °C	without R6; $I_{line} = 50 \text{ mA};$ $T_{amb} = -25 \text{ to } +75 \text{ }^\circ\text{C}$	–	± 0.2	–	dB
$V_{o(RMS)}$	output voltage (RMS value)	TDA = 2%; sinewave drive; $R_4 = 100 \text{ k}\Omega;$ $I_{line} = 15 \text{ mA}$				
	single-ended	$R_T = 150 \Omega$	–	0.2	–	V
	differential	$R_T = 450 \Omega$	–	0.37	–	V
	differential	$C_T = 47 \text{ nF};$ $R_s = 100 \Omega;$ $f = 3400 \text{ Hz}$	–	0.52	–	V
$V_{o(RMS)}$	output voltage (RMS value)	$I_p = 0 \text{ mA};$ TDA = 10%; sinewave drive; $R_4 = 100 \text{ k}\Omega;$ $R_T = 150 \Omega$				
		$I_{line} = 4 \text{ mA}$	–	20	–	mV
		$I_{line} = 7 \text{ mA}$	–	160	–	mV
$V_{no(RMS)}$	noise output voltage (RMS value)	$I_{line} = 15 \text{ mA};$ $R_4 = 100 \text{ k}\Omega;$ psophometrically weighted (P53 curve); pin IR open-circuit				
	single-ended	$R_T = 300 \Omega$	–	45	–	μV
	differential	$R_T = 600 \Omega$	–	90	–	μV
$V_{no(RMS)}$	noise output voltage (RMS value)	see Fig.21; S1 in position 2; 200 Ω between MIC– and MIC+; single-ended; $R_T = 300 \Omega$				
		$R_7 = 68 \text{ k}\Omega$	–	100	–	μV
		$R_7 = 24.9 \text{ k}\Omega$	–	65	–	μV

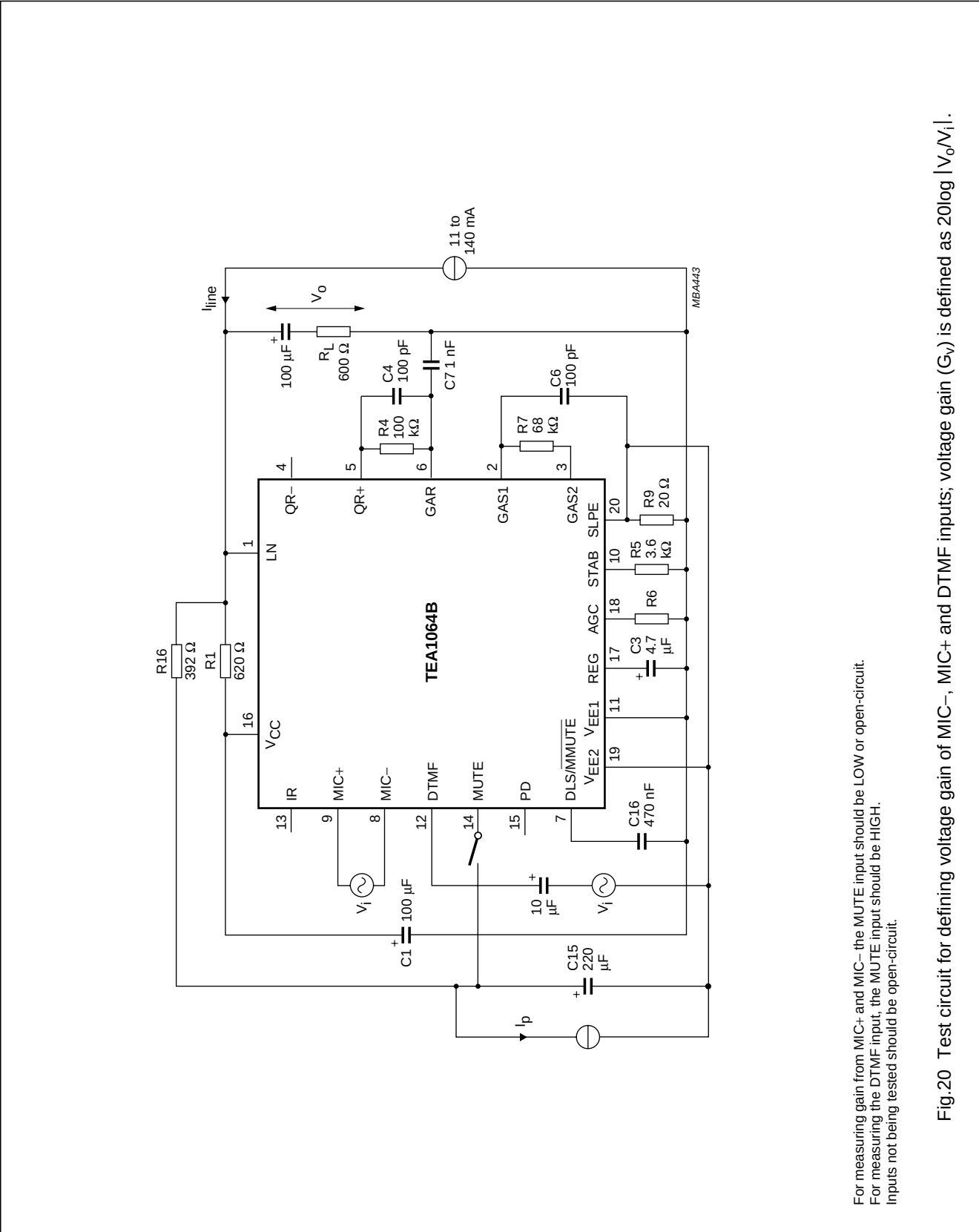
Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Gain adjustment input GAR (pin 6)						
ΔG_v	receiving amplifier gain adjustment range		-11	–	+8	dB
MUTE input (pin 14)						
V_{IH}	HIGH level input voltage		$1.5 + V_{EE2}$	–	$V_{CC} + 0.4$	V
V_{IL}	LOW level input voltage		0	–	$0.3 + V_{EE2}$	V
I_{mute}	input current		–	11	20	μA
ΔG_v	change of microphone amplifier gain at mute on	MUTE = HIGH	–	-100	–	dB
G_v	voltage gain from input DTMF-SLPE to QR+ output with mute on	MUTE = HIGH; single-ended load; $R_L = 300 \Omega$	–	-18	–	dB
Power-down input PD (pin 15)						
V_{IH}	HIGH level input voltage		$1.5 + V_{EE2}$	–	$V_{CC1} + 0.4$	V
V_{IL}	LOW level input voltage		0	–	$0.3 + V_{EE2}$	V
I_{PD}	input current		–	5	10	μA
Automatic gain control input AGC (pin 18)						
G_v	controlling the gain from IR (pin 13) to QR+, QR– (pins 4, 5) and the gain from MIC+, MIC– (pins 8, 9) to LN (pin 1) gain control range with respect to $I_{line} = 15 \text{ mA}$	$R6 = 93.1 \text{ k}\Omega$ (between pins 18 and 11) $I_{line} = 75 \text{ mA}$	-5.7	-6.1	-6.5	dB
I_{line}	highest line current for maximum gain		–	24	–	mA
I_{line}	lowest line current for minimum gain		–	61	–	mA
ΔG_v	change of gain between $I_{line} = 15$ and 35 mA		-0.9	-1.4	-1.9	dB
Microphone mute input DLS/MMUTE (pin 7)						
V_{IL}	LOW level input voltage		V_{EE1}	–	$V_{EE1} + 0.3$	V
I_{IL}	input current at LOW level input voltage		-85	-60	-35	μA
t_{rel}	release time after a LOW level on pin 7	$C16 = 470 \text{ nF}$	–	30	–	ms
ΔG_v	change of microphone amplifier gain at LOW level input voltage on pin 7		–	-100	–	dB

Low voltage versatile telephone transmission circuit
with dialler interface and transmit level dynamic limiting

TEA1064B



Low voltage versatile telephone transmission circuit
with dialler interface and transmit level dynamic limiting

TEA1064B

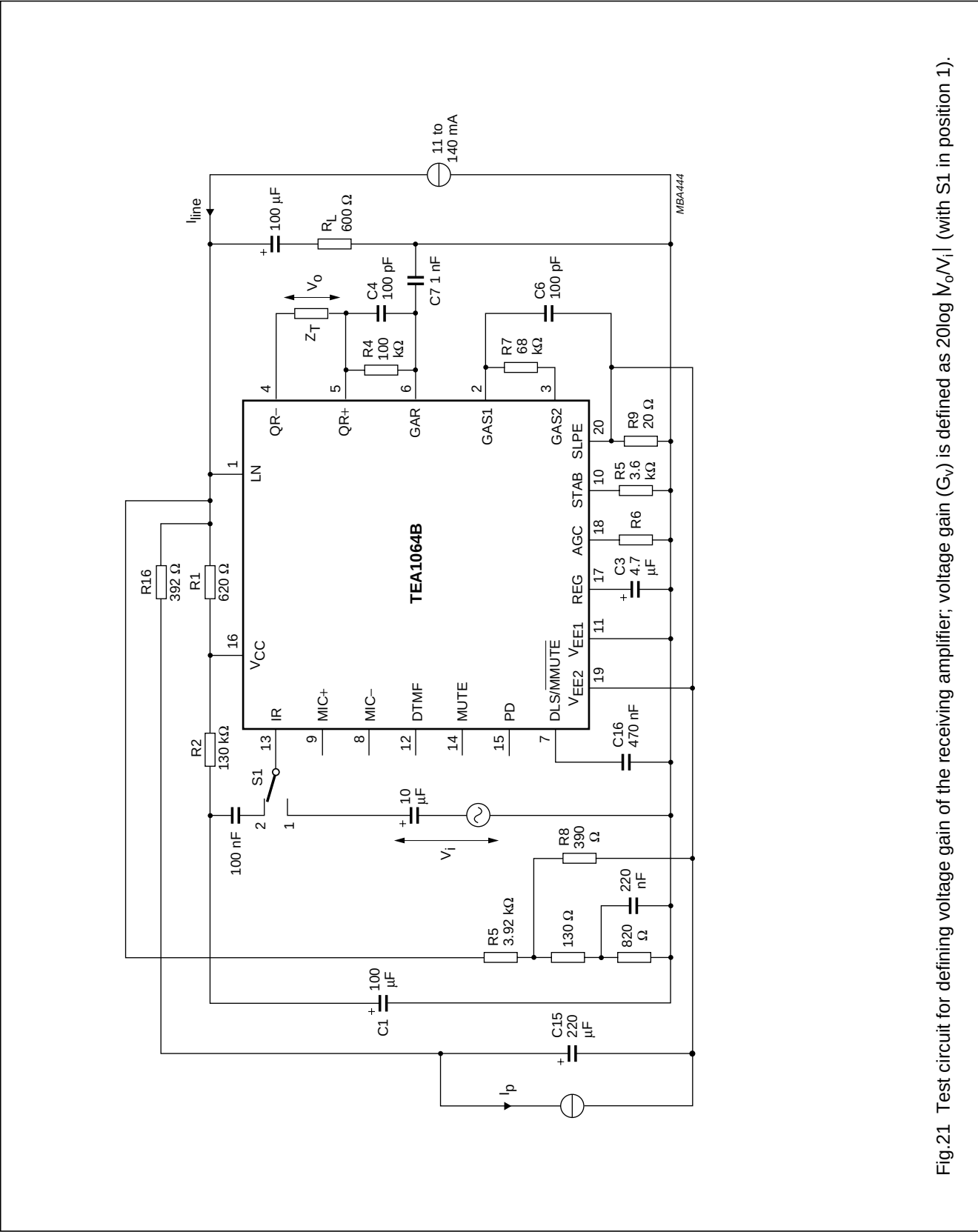


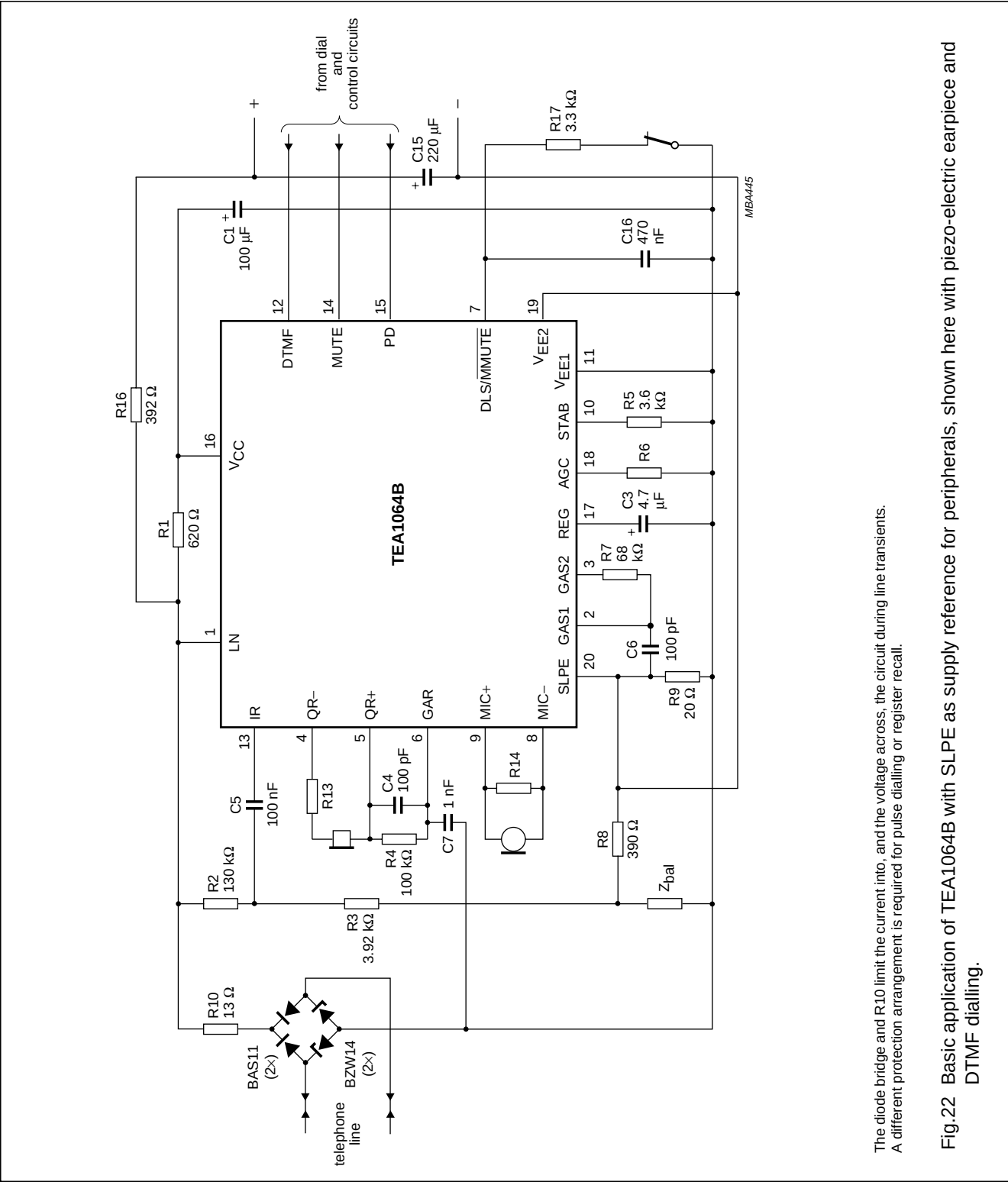
Fig.21 Test circuit for defining voltage gain of the receiving amplifier; voltage gain (G_v) is defined as $20\log V_o/V_i$ (with S1 in position 1).

Low voltage versatile telephone transmission circuit
with dialler interface and transmit level dynamic limiting

TEA1064B

APPLICATION INFORMATION

The basic application circuit is shown in Fig.22 and a typical application is shown in Fig.23.

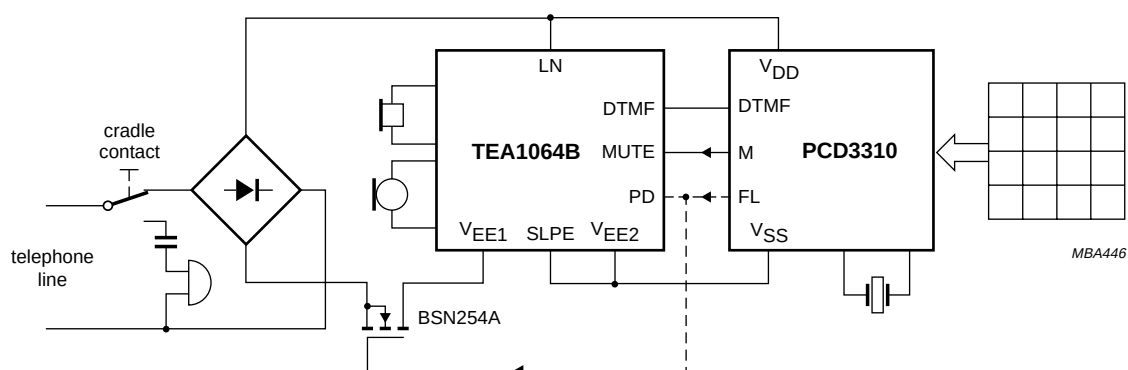


The diode bridge and R10 limit the current into, and the voltage across, the circuit during line transients.
A different protection arrangement is required for pulse dialling or register recall.

Fig.22 Basic application of TEA1064B with SLPE as supply reference for peripherals, shown here with piezo-electric earpiece and DTMF dialling.

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B



The broken line indicates optional flash (register recall by timed loop break).

Fig.23 Typical DTMF-pulse set application circuit (simplified) showing the TEA1064B with the CMOS bilingual dialling circuit PCD3310.

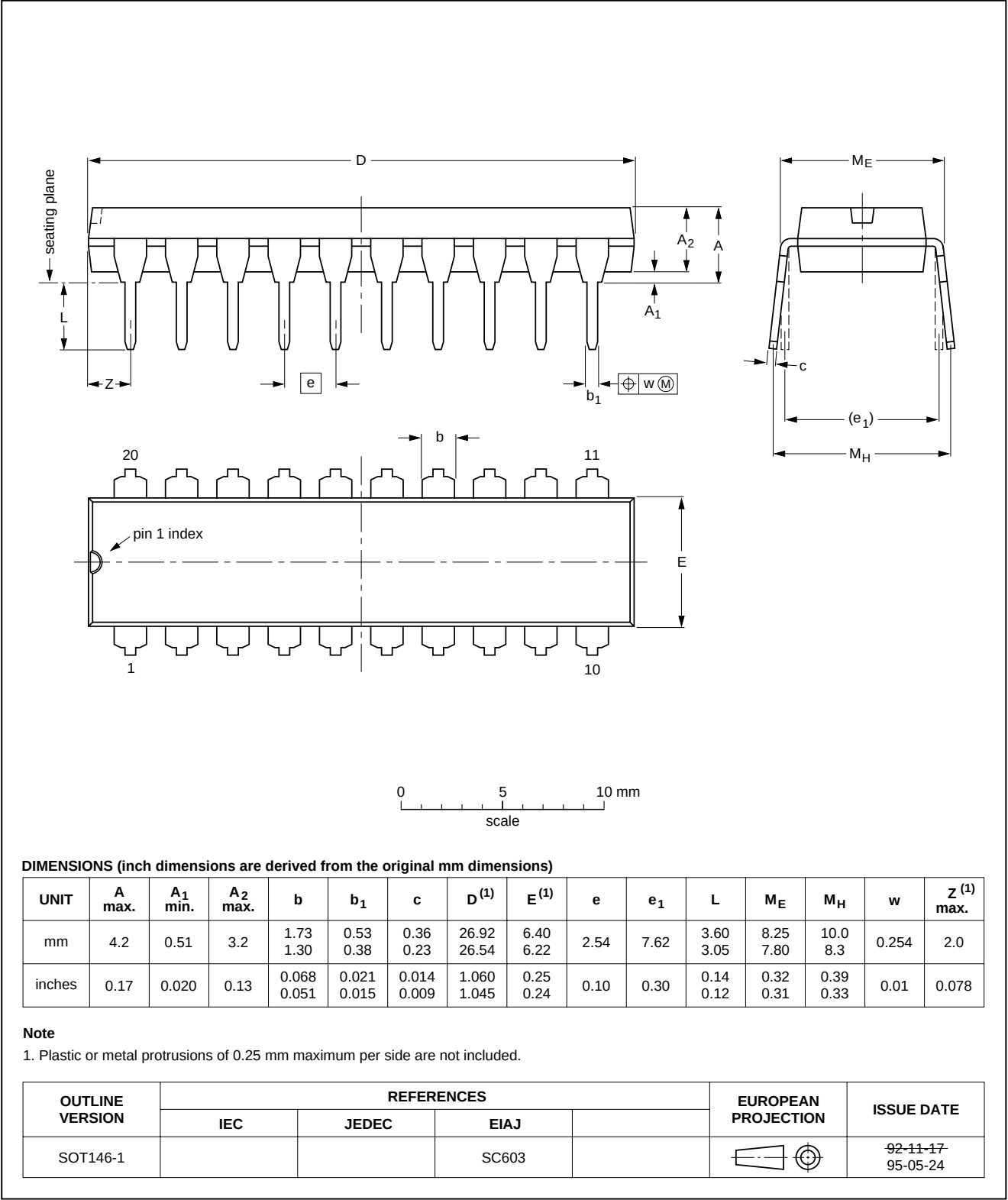
Low voltage versatile telephone transmission circuit
with dialler interface and transmit level dynamic limiting

TEA1064B

PACKAGE OUTLINES

DIP20: plastic dual in-line package; 20 leads (300 mil)

SOT146-1

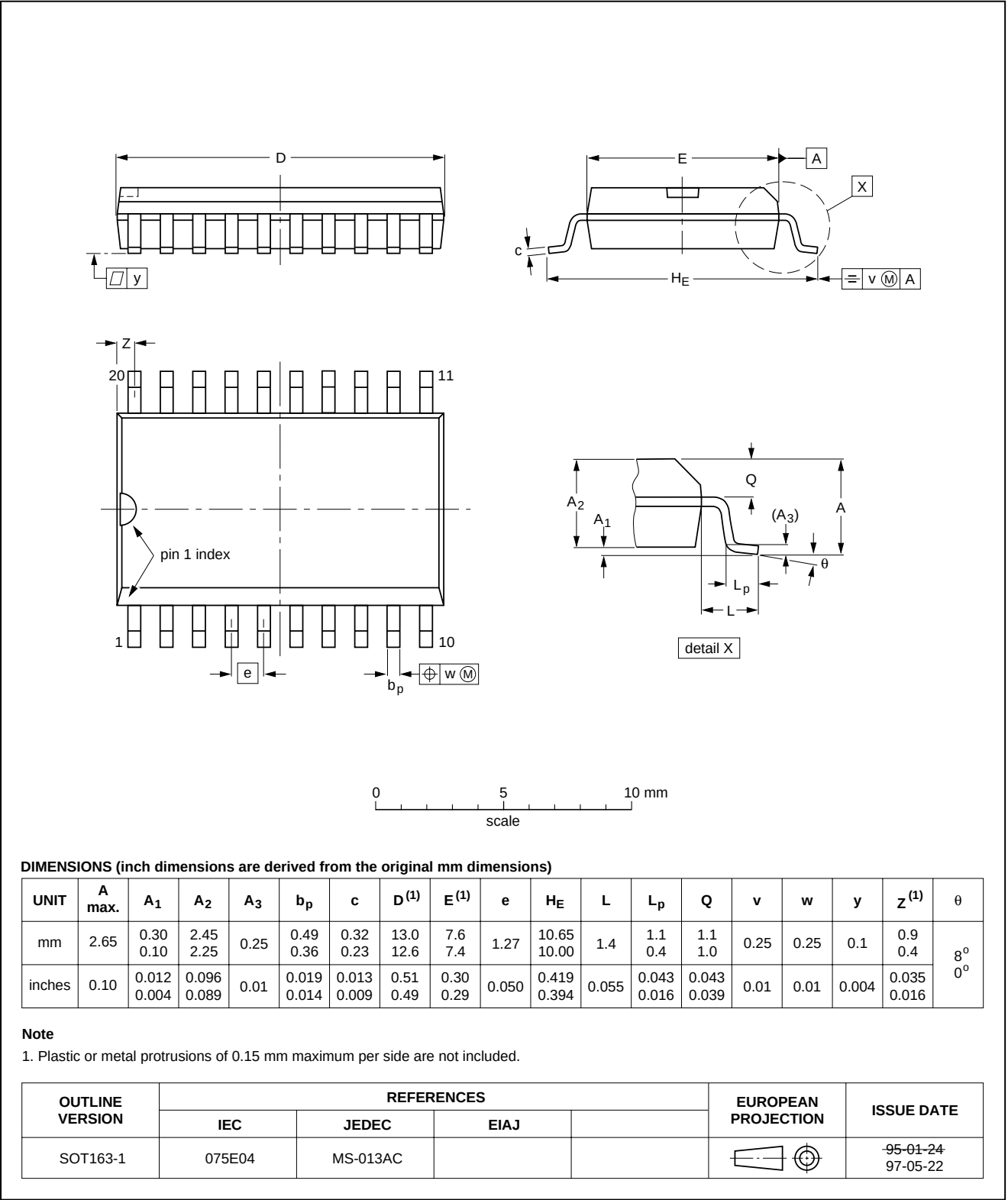


Low voltage versatile telephone transmission circuit
with dialler interface and transmit level dynamic limiting

TEA1064B

SO20: plastic small outline package; 20 leads; body width 7.5 mm

SOT163-1



Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

SOLDERING

Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (order code 9398 652 90011).

DIP

SOLDERING BY DIPPING OR BY WAVE

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg\ max}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

REPAIRING SOLDERED JOINTS

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

SO

REFLOW SOLDERING

Reflow soldering techniques are suitable for all SO packages.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

WAVE SOLDERING

Wave soldering techniques can be used for all SO packages if the following conditions are observed:

- A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.
- The longitudinal axis of the package footprint must be parallel to the solder flow.
- The package footprint must incorporate solder thieves at the downstream end.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

REPAIRING SOLDERED JOINTS

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

Low voltage versatile telephone transmission circuit
with dialler interface and transmit level dynamic limiting

TEA1064B

NOTES

Philips Semiconductors – a worldwide company

Argentina: see South America

Australia: 34 Waterloo Road, NORTH RYDE, NSW 2113,
Tel. +61 2 9805 4455, Fax. +61 2 9805 4466

Austria: Computerstr. 6, A-1101 WIEN, P.O. Box 213, Tel. +43 160 1010,
Fax. +43 160 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 200 733, Fax. +375 172 200 773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 689 211, Fax. +359 2 689 102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381

China/Hong Kong: 501 Hong Kong Industrial Technology Centre,
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,
Tel. +852 2319 7888, Fax. +852 2319 7700

Colombia: see South America

Czech Republic: see Austria

Denmark: Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S,
Tel. +45 32 88 2636, Fax. +45 31 57 0044

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615800, Fax. +358 9 61580920

France: 51 Rue Carnot, BP317, 92156 SURESNES Cedex,
Tel. +33 1 40 99 6161, Fax. +33 1 40 99 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 23 53 60, Fax. +49 40 23 536 300

Greece: No. 15, 25th March Street, GR 17778 TAVROS/ATHENS,
Tel. +30 1 4894 339/239, Fax. +30 1 4814 240

Hungary: see Austria

India: Philips INDIA Ltd, Band Box Building, 2nd floor,
254-D, Dr. Annie Besant Road, Worli, MUMBAI 400 025,
Tel. +91 22 493 8541, Fax. +91 22 493 0966

Indonesia: PT Philips Development Corporation, Semiconductors Division,
Gedung Philips, Jl. Buncit Raya Kav.99-100, JAKARTA 12510,
Tel. +62 21 794 0040 ext. 2501, Fax. +62 21 794 0080

Ireland: Newstead, Clonskeagh, DUBLIN 14,
Tel. +353 1 7640 000, Fax. +353 1 7640 200

Israel: RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053,
TEL AVIV 61180, Tel. +972 3 645 0444, Fax. +972 3 649 1007

Italy: PHILIPS SEMICONDUCTORS, Piazza IV Novembre 3,
20124 MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

Japan: Philips Bldg 13-37, Kohnan 2-chome, Minato-ku,
TOKYO 108-8507, Tel. +81 3 3740 5130, Fax. +81 3 3740 5077

Korea: Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. +82 2 709 1412, Fax. +82 2 709 1415

Malaysia: No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,
Tel. +60 3 750 5214, Fax. +60 3 757 4880

Mexico: 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,
Tel. +9-5 800 234 7381

Middle East: see Italy

Netherlands: Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,
Tel. +31 40 27 82785, Fax. +31 40 27 88399

New Zealand: 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,
Tel. +64 9 849 4160, Fax. +64 9 849 7811

Norway: Box 1, Manglerud 0612, OSLO,
Tel. +47 22 74 8000, Fax. +47 22 74 8341

Pakistan: see Singapore

Philippines: Philips Semiconductors Philippines Inc.,
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

Poland: Ul. Lukiska 10, PL 04-123 WARSZAWA,
Tel. +48 22 612 2831, Fax. +48 22 612 2327

Portugal: see Spain

Romania: see Italy

Russia: Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,
Tel. +7 095 755 6918, Fax. +7 095 755 6919

Singapore: Lorong 1, Toa Payoh, SINGAPORE 319762,
Tel. +65 350 2538, Fax. +65 251 6500

Slovakia: see Austria

Slovenia: see Italy

South Africa: S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,
2092 JOHANNESBURG, P.O. Box 7430 Johannesburg 2000,
Tel. +27 11 470 5911, Fax. +27 11 470 5494

South America: Al. Vicente Pinzon, 173, 6th floor,
04547-130 SÃO PAULO, SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 821 2382

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 93 301 6312, Fax. +34 93 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 5985 2000, Fax. +46 8 5985 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2741 Fax. +41 1 488 3263

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2865, Fax. +886 2 2134 2874

Thailand: PHILIPS ELECTRONICS (THAILAND) Ltd.,
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,
Tel. +66 2 745 4090, Fax. +66 2 398 0793

Turkey: Talatpasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,
Tel. +90 212 279 2770, Fax. +90 212 282 6707

Ukraine: PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

United Kingdom: Philips Semiconductors Ltd., 276 Bath Road, Hayes,
MIDDLESEX UB3 5BX, Tel. +44 181 730 5000, Fax. +44 181 754 8421

United States: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,
Tel. +1 800 234 7381

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 625 344, Fax. +381 11 635 777

For all other countries apply to: Philips Semiconductors,
International Marketing & Sales Communications, Building BE-p, P.O. Box 218,
5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

Internet: <http://www.semiconductors.philips.com>

© Philips Electronics N.V. 1998

SCA60

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner.

The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent- or other industrial or intellectual property rights.

Printed in The Netherlands

415102/00/02/pp32

Date of release: March 1994

Document order number: 9397 750 nnnnn

Let's make things better.

**Philips
Semiconductors**



PHILIPS